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THE OLD EROSION SURFACE IN IDAHO: A CRITICISM

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In another part of this volume,¹ Mr. Joseph B. Umpleby describes an old peneplain in the northwestern mountain states, and discusses the evidence bearing upon its age. The original planation was so nearly completed that comparatively few monadnocks were left. The surface truncates folded sedimentary and metamorphic rocks intruded by batholiths of granite, thought to be of Triassic or older age. Since it was made, the plain has been lifted into a plateau and then intrenched by systems of valleys, some of which are as much as 5,000 feet deep. In many places this process has completely destroyed the old peneplain, but in some parts of central Idaho it has left flat-topped remnants of considerable area. By putting together various observed facts, the author reaches the conclusion that the peneplain was made during the Eocene period, that it was then uplifted and the great valleys excavated during the Oligocene, and that in the bottoms of these depressions, lake beds were deposited in Miocene time.

I do not question the identification of the flat-topped remnants and accordant summits as parts of an old elevated peneplain, and it is evident that, as the author says, the plain was developed after the deformation of the strata about the close of the Cretaceous period. It does seem to me, however, that the facts given by the author himself, and others which may be noted here, lead necessarily to quite different conclusions regarding the age of the plain.

The first point in the author's chain of argument to prove the Eocene age of the peneplain is that so-called "lake-beds" of Miocene age were deposited in the valleys excavated in the old plateau after it was elevated. It is a fact that continental deposits of various ages are now found lining the bottoms of large depressions rather generally throughout the Rocky Mountain region, but there are

¹ *Journal of Geology*, XX, No. 2 (1912), pp. 139-47.

several ways in which such conditions may come about. One method is the deposition of the sediments in the bottoms of the valleys, in essentially their present state, as suggested in the article. Again where weak materials have been down-folded or down-faulted between masses of harder rocks, they may be eroded to a lowland on account of difference of resistance to denuding processes. Cases of this sort are well known in the Colorado park region and have been pointed out recently by Davis.¹ A third hypothesis is that the broad valleys occupied by the sediments were excavated and filled before the old peneplain was made. It is clear that if through differential changes of level such filled valleys came to lie below grade level for the streams of the planation period, the sediments could not be wholly removed, but would be as permanent as the most resistant rocks of their surroundings. The Cambrian sediments in the Baraboo Valley of Wisconsin illustrate the principle. If the author has considered these various possibilities, the paper presents no evidence to show that the first hypothesis has any advantage in this case over the second or the third.

The second point made is that the Oligocene period should be allowed for the development of the broad valleys in which the Miocene sediments are supposed to have been deposited. It may be pointed out here that most of the sediments mentioned are believed to be late Miocene, according to Osborn's² recent classification, so that it may be permissible to add the earlier part of the Miocene period to the time allowed for the process. Furthermore, erosion proceeds at such different rates under different circumstances, that it is quite impossible to estimate the amount of time necessary for the intrenchment of the Idaho plateau. It may be questioned whether the early Miocene epoch would not suffice, or why, on the other hand, it might not be necessary to add the Eocene to the Oligocene, to account for these valleys. Surely no trustworthy determination of the age of the peneplain can be attained by allowing a geologic period for a process of unknown time requirements.

¹ W. M. Davis, "Front Range in Colorado," *Annals of the Association of American Geographers*, I, 1912, p. 43.

² H. F. Osborn, "Genozoic Mammal Horizons of the West," *U.S. Geol. Survey Bull.* 361, 1909.

In the opinion of the author, there is a significant relation between the position of this dissected plateau and the bodies of Eocene sediments in the north Rockies and plains adjacent on the east. The inference is made that these sediments could not have been produced by the dissection of the plateau after it was elevated, partly because the volume of material obtainable from such dissection would be supposedly insufficient, and partly because the drainage seems to have been westward rather than eastward, since the uplift.

In the first place, it seems evident that no sufficient quantitative study has ever been made of the volume of either the Eocene sediments or the material removed in dissecting the plateau, to give the first argument any considerable weight, especially as we do not know to what extent other regions to the north, east, or south may have contributed sediments. As to the second point also, it may be said that no connection has been shown between the Eocene strata and the source of the sediments, and that it seems within the bounds of probability that material may have come from several other directions as well as from the west. In this connection I may point out that Mr. Umpleby's map, showing the distribution of sediments of Eocene age which he thinks may have been derived from the peneplain, includes large outcrops of the Fort Union and correlative formations. Yet the Fort Union in the north Rockies has been upturned, folded, and beveled off, and upon its truncated edges the Lower Eocene strata were subsequently deposited. It would therefore seem necessary to believe that the Fort Union formation was deposited before the completion of the deformative movements which the author rightly thinks preceded the cycle of erosion represented by the peneplain.

For these reasons I can see but little value in the train of argument by which the author reaches the conclusion that the peneplain furnished the material for the Eocene sediments and which leads him to say: "That the plateau surface is of Eocene age, there seems to be little room for doubt." In view of the fact that several interpretations other than those suggested by the author may be applied to the observed data, it seems to me that there is very large room for doubt. There are, indeed, some additional facts

which are matters of general knowledge, that seem to indicate a much later age than Eocene for the plateau surface described by Mr. Umpleby. These necessitate a short introduction for the sake of clearness.

It is said that "faulting and folding have affected the plateau area of central and eastern Idaho since its last elevation, but through all, the integrity of the old surface has persisted in a remarkable degree." In the preceding paragraph, however, it is pointed out that the remnants of the peneplain do not vary greatly in altitude, the maximum being 10,000 feet in central Idaho and from that falling off very gradually to 8,000, 7,000, and even 5,000 feet at a distance of some 400 miles. Unless there is some other evidence of the supposed folding and faulting, the reader is justified in concluding from the facts presented that the plain has been subject merely to very gentle changes of level, which may be termed mild warping, rather than folding. This very slightly warped condition of the old peneplain should be compared with the much more pronounced deformation visible in the late Eocene sediments and lavas of closely adjacent regions on several sides. Thus, immediately southeast of the region under consideration, the late Eocene and Oligocene beds of northwestern Wyoming have an average dip of 10° and in some places form anticlines with 25° dips on either limb. In addition to this, they have been broken by normal faults of several thousand feet displacement. Again, on the southwestern confines of the central Idaho region itself, the Payette formation, which seems to be safely identified by fossil plants as of late Eocene age, varies in elevation from less than 1,000 feet above sea-level near Weiser, to nearly 6,900 feet above sea-level east of Boise.¹ In the same region the dip of the fine plant-bearing shales, which were doubtless deposited in horizontal position, is now generally $10\text{--}15^{\circ}$, and not rarely 25° ; while at a one point it rises as high as 80° . Still more striking is the condition in west-central Washington, less than 100 miles from the Republic district in which the old peneplain is said to be readily identified. There the Eocene and even the late Miocene formations

¹ W. Lindgren and N. F. Drake, *U.S. Geol. Survey*, Folio 104, Silver City, Idaho, 1904.

have been shown by Willis¹ and Smith and Calkins² to be notably folded into a series of well-marked anticlines and synclines. There seems to be adequate proof in the Snoqualmie quadrangle that this deformation took place about the middle of the Miocene period, so that the case is relieved of the usual difficulties arising from uncertainties of correlation. If the peneplain is Eocene in age it must have suffered the same deformation that produced in these Eocene strata average dips of 10° and in many places of more than 25°. Under those circumstances it could not retain so nearly its original plane character that (barring entrenched valleys) it still differs in altitude only 5,000 feet in 400 miles, or in other words, declivities of but a small fraction of one degree. Rather, the evidence seems to show that this peneplain is much younger than Eocene and probably post-middle-Miocene.

The comments here made upon Mr. Umpleby's article have been called forth by the fact that the peneplain, definitely assigned to the Eocene, is offered to students of Rocky Mountain geology as a valuable "datum plane in broad areas where time relations between the Algonkian and the Pleistocene are otherwise obscured." The peneplain probably has real existence, and may be used as a datum plane to determine the relative ages of other geologic events in the same region; but it should not be regarded as an index of Eocene age, and its exact chronological value will depend upon a more reliable future determination.

¹ G. O. Smith and B. Willis, "Geology of Central Washington," *U.S. Geol. Survey, Prof. Paper 19*, 1904.

² G. O. SMITH and F. C. CALKINS, "Reconnaissance of the Cascade Range," *U.S. Geol. Survey, Bull. 235*, 1904. Also Snoqualmie, Wash., Folio (139), *U.S. Geol. Survey*, 1906.